Oil production and abrupt institutional change: the multi-cyclic Hubbert model and the case of Iraq

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ABSTRACT
Iraq, one of the world’s leading crude oil producers with the fifth largest share of proven global oil reserves, recently ranked as the second-largest producer among Organization of the Petroleum Exporting Countries (OPEC) members. Nevertheless, performance of the upstream subsector in terms of oil production volume has been subject to severe disruptions for more than four decades. The main sources for these fluctuations are multi-institutional changes caused by nationalization, wars and United Nations sanctions. This article applies to the Iraqi case an extended version of the multi-cycle Hubbert model, developed by Reynolds and Kolodziej in 2008 and 2009. This econometrics model explores and attempts to quantify statistically the relationship between oil production and multi-institutional changes within Iraq. Findings indicate the negative and significant impacts of abrupt institutional change on the performance of the oil industry where this adverse impact varies in magnitude from one episode to another. As Iraq is still yet in the midst of a turbulent transition, the article also discusses the major challenges of the post-2003 era, associated with the present and potential future development of the Iraqi oil-producing sector. This is especially with regard to the increasing economic and political fragmentation that stems from the absence of a unified oil policy.

KEYWORDS
Iraqi oil production; impact of wars; institutional change; Iraq; multi-cycle Hubbert model; case study

Introduction
After decades of wars, United Nations (UN) sanctions and internal conflicts, Iraq is returning to the oil market that it has been forced to leave several times – either partially or completely. The nation is attempting to re-establish itself gradually among the world’s major oil producers in hopes of regaining its lost market share (Six and Van Geuns 2014).

In 2015, Iraq produced 3.50 million barrels per day (Mb/d), while exports were calculated at 3.00 Mb/d (Organization of Petroleum Exporting Countries (OPEC) 2016). This constitutes a significant increase from the 1.37 Mb/d in exports during 2003; and for the first time, the volume of Iraq’s production has increased beyond its previous historical peak of 3.47 Mb/d in 1979 (OPEC 2008).

In point of fact, since the 1950s, the oil-producing sector (hereafter also referred to as the upstream subsector) has been of the most primary importance to the Iraqi
economy, eclipsing the agricultural sector (Yousif 2012). This is well illustrated by the high average ratio of oil revenue to total budget revenues, which averaged 80.30% between 1959 and 1970 (Brown 1979). Similarly, this trend – which has only been increasing – is demonstrated by the high contribution of oil to the gross domestic product (GDP). For instance, the average oil rent ratio more than doubled from 1980 to 2014, where the ratio increased from 23.10% in 1980–89 to 53.30% in 2004–14 (World Bank 2015). The oil rent ratio is obtained as ‘the difference between the value of crude oil production at world prices and total costs of production’ (World Bank 2015).

Iraq had been engaged, since 1980, in a series of armed conflicts: the Iraq–Iran War (1980–88); the First Gulf War (1990–91), which led to more than a decade of UN sanctions (1990–2003); and the Iraq War of 2003 (the Second Gulf War) – all of which have had undeniable consequences for the Iraqi economy (Mofid 1990; Alnasrawi 1986, 1992, 1994; Rowat 2007; Yousif 2012, 2016; El-Joumayle 2016). As was to be expected, the oil-producing sector was impacted directly and significantly by these events, which were reflected in numerous ways including huge volatility in production volume, as will be discussed.

This decline in production volume and loss of market share proved to be exceedingly costly for Iraq. In this context, in a rough calculation done by Nordhaus (2002) based on the decrease in levels of oil production, it was estimated that the UN sanctions alone, during the 1991–2002 period, reduced Iraq’s oil revenues by the equivalent of approximately six years of GDP. On this basis, Owen (2007) has aptly labelled the period of wars and UN sanctions (1980–2003) as ‘the lost decades’.

Though some leading OPEC members have also experienced severe production swings over time that were associated with certain socio-political factors (see Anderson and Conder 2011 for the cases of Nigeria and Libya), Iraq constitutes a unique case study due to the fact that the country has witnessed a greater variety of abrupt institutional changes in its recent history than any other OPEC member state.

In this context, the term ‘institutional change’ is intended to connote an appropriate change in governance structure that successfully promotes economic growth (Libecap 1989). Of course, not all institutional changes lead to economic growth; unsuccessful change, for instance, in governance structure essentially precipitates the opposite of intended results, such as stagnation or, possibly, economic decline.

The New Institutional Economics (NIE) considers institutional change as central to the development process, where development is defined as the sum of economic growth and appropriate institutional change, in which the latter paves the way for further economic growth (Toye 1995).

The most frequently cited definition of the term ‘institutions’ comes from Douglass North to the effect that: ‘Institutions are any constraints humans devise to shape their interactions’ (North 1990, 3). One of the most important features of social institutions is that they tend to be relatively stable and durable so they assist in creating and promoting order (Kingston and Caballero 2009). This being said, institutional change typically occurs when the institutional arrangements (i.e., rules, norms and enforcement) undergo marginal adjustments over time and in a gradual manner (North 1990). Thus, the emergence of certain social, political and economic circumstances constitute key dynamics undergirding change in institutions, whether such occurs gradually or in a discontinuous and abrupt or sudden manner. The latter sort of transformation is an exception and is, most
frequently, the result of natural disasters (such as floods, hurricanes, earthquakes and sandstorms) or man-made events (such as revolutions, wars or invasions), where the formal ‘rules of the game’ change radically overnight (North 1990).

This article is based on the assumption that the discontinuous institutional changes that have transpired in Iraq have entailed long-term ramifications on the performance of the oil-producing sector, while, due to lack of a unified national vision for economic development, the institutional change of 2003 formed the basis of constant tension and uncertainty over the present and future fate of the oil-producing sector.

Its contribution to the field lies in its being possibly the first attempt (so far as is known) made to examine empirically the impact of discontinuous institutional changes on the performance of the Iraqi upstream subsector; that is, the nationalization of oil production in 1972 and the multi-structural changes – caused by three wars – on the volume of production.

As concerns the scope of the present article, two caveats ought to be stated at the outset. First, the causes behind the course of events and their historical development (i.e., the nationalization of oil, the various wars and UN sanctions) are not examined here, since they have been amply documented and analysed elsewhere (e.g., Farouk-Sluglett and Sluglett 2003; Tripp 2007; Anaz 2012; Ismael and Ismael 2015; Stern 2016). Second, as the scope of the article is constrained to the sector level – that of the oil-producing sector – the role of oil in economic development is implicitly addressed.3

The article is organized as follows. The next section presents some essential historical data about the Iraqi oil-producing sector, including the impact of the wars on production levels. The third section provides a brief review of the relevant literature. The fourth section reviews the Hubbert model (Hubbert 1956, 1962) and employs it in a modified form that takes into account abrupt institutional changes. The fifth section discusses the results. The last section concludes.

**Oil production in Iraq: some relevant facts**

It may be useful here to begin by providing a brief historical review of the Iraqi upstream subsector. In this regard, a number of essential observations about the development of Iraqi oil production for the period under study are made.

Although oil was first discovered in the 19th century, production volume only became significant after the exploration of Kirkuk giant oilfield in northern Iraq – Baba Gurgur is one of the three domes of the giant Kirkuk oilfield, which refers to Kirkuk 1, the country’s first well – discovered in October 1927 by the Iraq Petroleum Company (IPC). This occurred only a short time after the founding of the IPC in 1925,4 when it was granted concessions for exploration and production of oil for a 75-year period (Koucher 1999).

In the 1930s, IPC’s two affiliates – Mosul Petroleum Company (MPC) and Basra Petroleum Company (BPC) – obtained 75-year agreements (Alnasrawi 1994). These contracts shaped the nature of oil sector for approximately the next 50 years, during which time production and exploration were managed by the Multinational Oil Corporation under the concession system, until nationalization of the sector took place on 1 June 1972.5

In less than a decade, oil production increased from 2.7 thousand barrels per day (kb/d) in 1928 to 78.1 kb/d in 1935 (OPEC 2008). By the end of the same year, Iraqi oil entered
the export market after the northern fields in Kirkuk were connected to the Mediterranean ports of Tripoli and Haifa via pipelines (Zedalis 2009). As a consequence, oil revenues of the Iraqi government doubled, increasing from 0.7 million Iraqi dinars (ID) in 1934 to ID1.5 million in 1935 (Koucher 1999). Nevertheless, even after the subsequent further increase in oil production during the 1940s, which exceeded 100 kb/d in 1945 (OPEC 2008), Iraqi oil revenues were still not more than ID2.3 million (Brown 1979). Thus, until 1950, the oil sector provided less foreign currency than did exported agricultural commodities (Yousif 2012).

After significant events in the oil market in the late 1940s and early 1950s, such as the nationalization of Iranian oil and the implementation of the profit-sharing principle adopted by producing countries such as Saudi Arabia and Venezuela, in 1952 Iraq signed more favourable deals under which the oil companies and the government agreed to share annual profits on a 50:50 basis (Muttitt 2007). As a result, Iraqi oil revenues increased from ID2 million to ID79.9 million during 1948–58 (Franze’n 2009). In this way, the oil industry has constituted the driving force of Iraqi economy since the 1950s (Yousif 2012).

Figure 1 shows the historical data of Iraq production for 1928–2015. This indicates that annual Iraqi oil production experienced several clear changes in direction. A more careful examination of the data reveals two distinct periods: 1928–79 and 1980–2015. For the first period (1928–79), oil production increased in a steady manner. Though there were occasional dips in production, the compound annual growth rate in annual production hovered around 15.40% for 1928–79; and it was pegged at about 9.50% for 1973–79. The major cause of these short-term disruptions lies in military operations that occurred with Middle East conflicts. To be precise, the OPEC data reveal that the drop was caused by the following wars: the Anglo-Iraqi War of 1941; the Palestinian War of 1948; and the Suez Canal War of 1956. Additionally, oil production dropped as a result of two episodes: the outbreak of a dispute over transport fees between the IPC and the Syrian government in 1966–67 (Brown 1979) and the nationalization of Iraqi oil in 1972 (OPEC 2008).

In sum, for 1928–79, production volume was halted for relatively short periods of time—regaining, however, in each case, its previous levels quickly and subsequently increasing thereafter to reach its premature peak in 1979.

On the other hand, it is also important to note that the relationship of successive Iraqi governments with international oil companies (IOCs) during 1960–71 was influenced by the manifest ascendency of greater national control over oil resources among the producing countries, moving away from the dominance of these companies. This was reflected by frequent calls for nationalization among the OPEC members throughout the 1960s—calls that were often answered (for the case of Iraq, see Hasan 1967; and Haseeb 1968).

The issues that prompted successive Iraqi government to renegotiate the oil concession agreements had to do with the amount of royalties paid, the delay in expanding the production levels, the building of refineries and Iraqi participation in the IPC (Zedalis 2009). Although disagreement was relatively common between the Iraqi government and the IPC, the attitudes adopted by governments under the monarchy (1921–1958) were more pragmatic, giving rise to far fewer disputes than those in IPC negotiations with the post-1958 republican regimes (Brown 1979).

In the post-1958 era, disputes between the two sides often proved confrontational. However, there was awareness of the serious political and economic consequences potentially associated with any oil-producing country’s attempt at comprehensive nationalization (Alnasrawi 1994; Koucher 1999). In addition, Iraq lacked both the essential managerial and technical capabilities to overcome any resultant absence of the IPC from the field in the event of nationalization. This led to the issuance of a modest version of Law No. 80 in 1961, in which IPC retained only 0.5% of its original concessions areas (Brown 1979). The capabilities of the Iraqi government did not improve in this sphere, even after the creation of the Iraq National Oil Company (INOC) in 1964, given the company’s lack of both the requisite resources and necessary political support (Alnasrawi 1994).

Furthermore, oil policy within the oil industry has been characterized as unclear and inconsistent, especially in connection with the intended role of the IPC, on one side, and the newly established INOC, on the other (Koucher 1999). In 1967, two laws were passed with the aims of expanding the role of INOC and banning any further concessions to foreign companies (Koucher 1999).

The 1970s were characterized by a major changes in the leading OPEC countries in terms of nationalization and increasing tax rates on oil company profits (Muttitt 2007; Reynolds and Pippenger 2010). This affected the production and exploration operations managed by state-owned companies (Mahdi 2007b) and Iraq constituted part of these changes.

Essentially, the chain of previous events facilitated the nationalization of the Iraqi oil industry during 1972–75, following the promulgation of Law No. 69, in June 1972. There were two major factors that made comprehensive nationalization possible. One was the ability of the Iraqi government to neutralize the substantial impact of the IPC on oil production and—consequently—on the Iraqi economy. This is based on two sub-factors. The first was based on: (a) the viability of the INOC as an organization, with its increasing operational capabilities (Koucher 1999); and (b), the substantive technical and financial assistance and—more importantly—the marketing of INOC oil as underwritten and guaranteed by the Soviet Union (Brown 1979; Smolansky and
Smolansky 1991). The second major factor was that the Iraqi decision was backed by
demonstrated support of other OPEC members, which prevented IOCs whose assets
had been nationalized from expanding its operations in other OPEC member countries
(Reynolds and Kolodziej 2007).

As a result of nationalization, the volume of production increased from 1.46 Mb/d in
1972 to 3.47 Mb/d in 1979 (OPEC 2008), with an Iraqi government target of increasing
it to 6 Mb/d in 1996 (Zedalis 2009; Alamir 2015). And furthermore, in just over a
decade after nationalization in 1972, the proven reserves also rose to 108 billion barrels,
after adding 74 billion barrels by the Iraqi-nationalized industry (Mahdi 2007b). In the
meantime, Iraq’s oil policy in the immediate post-nationalization era was geared
towards maximizing production volume and revenues, even though this was sometimes
counter to OPEC policy (Mahdi 2007b).

The trend of Iraqi oil production has changed drastically since 1980. Figure 1 shows the
high rate of volatility in production volume for 1980–2015. Oil production plummeted
dramatically in 1980 as a result of the Iraq–Iran War, and recovered gradually up until
August 1990. In 1991, another sharp drop occurred in conjunction with the First Gulf
War and attendant UN sanctions, followed by a sluggish recovery after implementing
the ‘Oil for Food’ programme in 1996. Finally in 2003, the production curve shows a
third, sharp decline after the outbreak of the Iraq War in March, but increases slowly
thereafter following on two rounds of licensing oil fields to IOCs in 2008/09.

The evidence shows that the oil industry was the first casualty after the outbreak of the
Iraq–Iran War in September 1980, in the sense that the destruction spread to oil facilities
including export terminals, refineries, pumping stations and pipelines, and export outlets
closed through the Persian Gulf (Alnasrawi 1986, 1994). The export pipeline through Syria
was also shut down from 1982 to 2000 due to Syria’s official siding with Iran during the
war (Zedalis 2009); and it still remains closed to date. Additionally, military operations
associated with the First Gulf War and the UN sanctions regime caused a complete halt
in exported oil for the entire 1991–96 period, while average production volume was
limited to about 500 kb/d, a restricted quantity intend mainly to cover local consumption
only (OPEC 2008; Zedalis 2009). Other than this, oil exports were effectively shut down,
with the exception of some illicit cross-border smuggling activities of limited scope with
neighbouring countries (Rowat 2007; Bozcali 2008).

According to OPEC (2008), after the beginning of the UN Oil for Food programme in
1996, production began to pick up from 740 kb/d, which primarily covered local con-
sumption, to 2.81 Mb/d in 2000 and 2.59 Mb/d in 2001. However, production dropped
once again to 1.37 Mb/d as a consequence of the outbreak of the Iraq War in 2003; and
began to increase slowly to 3.50 Mb/d in 2015 (OPEC 2008, 2016). From 1979
onwards, overall focus shifted from increasing production capacity into maintaining
and repairing the destroyed facilities (Mahdi 2007b); and given its proven oil reserves,
Iraq has the capacity potentially to produce more than it does presently (Shafiq 2013).

Table 1 indicates the major disruptions in Iraq production. The historical data indicate
simply that the rate of decline is much sharper and more protracted for the sub-period of
1980–2015 than the rate of increase (Figure 1).

Finally, although oil production in Iraq began about 80 years ago, cumulative oil pro-
duction up until 2013 accounts for only some 8% of the base oil reserves, which means the
country is actually capable of sustaining a high rate of production, while the other
producers, including Saudi Arabia, have already entered and passed through their peak production period and are beginning to witness production decline (Shafiq 2013).

One of the defining features of Iraq’s oil production is that it was subject to both short- and long-term disturbances. However, since 1980, there have been widespread disruptions. Thus, the volume of Iraqi production is clearly not time dependent, since the historical production data can be characterized as largely erratic due to the shocks resulting from political and military upheavals.

**A brief review of the literature**

Before we carry out the econometrics analysis, it is useful to review the relevant literature which consists of the essential literature of NIE in connection with institutional change. This is best suited for use as a complementary source of knowledge to support the key arguments and underlying assumptions of the present article.

The economic literature provides substantial evidence to suggest that institutions are important for economic development. Since the 1990s, the field of NIE has attracted considerable attention from policy-makers and practitioners, once institutions began incorporating economic analysis.

The works of North (1971, 1981, 1990) and others (e.g., Eggertsson 1990, 2008; Toye 1995; Williamson 2000, 2008; Acemoglu, Johnson, and Robinson 2005; Acemoglu and Robinson 2012) have made important contributions to the study of institutions, their role in the development of societies and how they influence economic performance. According to Kohn (2009), the NIE has brought into focus the entire economic environment rather than limiting the scope to the technology and economic resources by which

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**Table 1. Major disruptions in Iraq oil production for the period 1928–2015.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
<th>Average production (b/d, thousands)</th>
<th>Drop in average oil production (%)</th>
<th>Crude oil price (US $/barrel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1941</td>
<td>Anglo-Iraq War (May 1941)</td>
<td>36(^b)</td>
<td>–35.1</td>
<td>17.30</td>
</tr>
<tr>
<td>1948</td>
<td>The Palestinian War (outbreak in May 1948)</td>
<td>76(^c)</td>
<td>–25.6</td>
<td>19.58</td>
</tr>
<tr>
<td>1956</td>
<td>Suez Canal Crisis (July 1956)</td>
<td>641</td>
<td>–8.0(^d)</td>
<td>16.82</td>
</tr>
<tr>
<td>1967</td>
<td>Syrian pipelines dispute (1966/67)</td>
<td>1228</td>
<td>–11.8</td>
<td>12.77</td>
</tr>
<tr>
<td>1991</td>
<td>First Gulf War (invasion of Kuwait in August 1990)</td>
<td>282</td>
<td>–86.6</td>
<td>34.81</td>
</tr>
<tr>
<td>2003</td>
<td>Second Gulf War (Iraq War) (outbreak in March 2003)</td>
<td>1377</td>
<td>–35.2</td>
<td>37.14</td>
</tr>
</tbody>
</table>


\(^b\)The military operations associated with the Second World War in the Mediterranean Sea caused at least a partial drop in production volume during for 1939–41.

\(^c\)According to Zedalis (2009), the 1948 war caused an interruption in oil pipeline shipments to Haifa, while later on the shipments ceased altogether. Actually the Palestinian War of 1948 affected the volume of production in 1948 and 1949 respectively (OPEC 2008).

\(^d\)The drop even increased in 1957 to 449.5 kb/d to reach about (–30%) (OPEC 2008).

\(^e\)According to Alnasrawi (1986), before the outbreak of the Iraq–Iran War, Iraq ranked in 1979 as the second-largest OPEC oil producer/exporter after Saudi Arabia.

institutions – social and political structures – either facilitate or hinder productive economic activities.

It is important to note here that the NIE approach makes intuitive sense and is supported by an expanding body of research. Detailed surveys of literature have been provided by Aron (2000), Jütting (2003), Chakravarti (2008) and Law, Lim and Ismail (2013). According to Eggertsson (1996), the effects of institutional change on a nation’s economy can be summarized as follows: ‘The sequence of institutional change may move the economy either away from an efficient (wealth-enhancing) institutional structure or in [the] direction of such a structure’ (12). Jütting (2003) made the important point that although there is an increasing focus on incidents of institutional change, there still remains the need for more scholarly efforts to cover the different dimensions of and perspectives on institutional change. In this regard, notable efforts have been made by Kingston and Caballero (2009) in reviewing the different academic approaches to dealing with institutional change. Some scholars have even attempted to formulate a theory of institutional change (e.g., Chakravarti 2008; Tang 2012). Nevertheless, the existing discussions are not yet grounded in a coherent theory of clear and solid predictive value.

Along a parallel line, empirical research has expanded to include exploration for and production of oil and gas. Econometrics techniques have been employed to investigate a variety of case studies around the world, including the United States, Russia, the territories of the former Soviet Union, Venezuela and Tunisia (Reynolds and Zhao 2007; Reynolds and Kolodziej 2007, 2008, 2009; Reynolds and Pippenger 2010; Necibi 2014). The primary contribution of these case studies lies in their explanations for the occurrence of an abnormal pattern in Hubbert’s model, which is linked mainly to change in institutions. Reynolds (1999, 2002, 2013) is one of few authors who does explicitly focus on modelling the institutional element using the widely known Hubbert’s model (Hubbert 1956, 1962). Thus, Reynolds and Kolodziej (2008, 2009) have developed an extension of the basic model which explores the relationship between a declining (or increasing) production trend as correlated to changes in institutions.

In connection with the Iraq case, considerable attention has been paid to the qualitative evaluation of the implemented development policies (driven by oil revenues from as well as impacted by the various wars) by assessing their effects on the economy, society and institutions of the state (e.g., Alnasrawi 1994; Koucher 1999; Mahdi 2000; Yousif 2012, 2016). Moreover, several scholars have carried out an analysis of the Iraq oil industry after the 2003 war (Khadduri 2011; Muttit 2007, 2012; Mahdi 2007a; Jiyad 2008, 2010, 2011; Nakhle 2008; Žedalis 2009, 2012; Cameron 2010, 2011). Most of these works address the attendant economic and judicial issues centred around the re-emergence of the Iraqi oil-producing sector and the deliberate development of divergent oil policies by the federal and regional governments.

This research is fuelled by ongoing debate over the interpretation of the 2005 Constitution in connection with the management and development of the upstream petroleum subsector (e.g., Al-Mehaidei 2012; Ferhang 2013). Some scholars have gone so far as to compare the financial outcomes of the federal government’s long-term service contracts (LTSCs) with the production share contracts (PSCs) of the Kurdish Region Government (KRG). The aim of these studies is essentially to demonstrate the ‘superiority’ of one model over the other (e.g., Al-Mehaidei 2012; Mills 2016).
Instead, this article is concerned primarily with the somewhat broader question of how to measure empirically the abrupt institutional changes and their impact on the performance of the Iraq oil-producing sector.

**Methodology, scope and model specifications**

**Methodology**

In principle, the theoretical plan outlined by Alston (1996), who proposed that examination would proceed on two levels, is followed. One level entails distinguishing between the causes and consequences of institutional changes. The other level focuses on investigating either the causes or the consequences of institutional change. Nevertheless, when the major focus is directed towards *causes*, analysis necessary includes some elements of consequences, and vice versa.

According to the NIE, conventional wisdom dictates that understanding the past, present and potential future performance of the Iraqi oil-producing sector essentially would lead us to consider the path dependency of oil production for 1928–2015. Path dependency describes how the patterns of the past tend to shape the future, or, in other words, how the sequence of past events and decisions guide future decisions. In short, and common parlance: history *matters* (North 1990; Ebbinghaus 2005).

As noted, the causes of the abrupt institutional changes are not the focus of the current article; but evidence indicates that wars *are* connected in what presents as a type of *series of events*. Thus, it may be useful to highlight here two key points. First, scholars often subscribe to a widespread belief that the oil price collapse in the 1980s, coupled with the negative economic consequences of the Iraq–Iran War, lay behind the causes for the First Gulf War (Chaudhry 1991; Tripp 2007; Yousif 2012). And second, while the Iraq War of 2003 (the Second Gulf War) is considered by some to be the ‘final phase’ of ‘unfinished objectives’ from the First Gulf War, some researchers have argued that the Iraq War of 2003 was less about oil than the overarching strategic/geopolitical context: in other words, the war would provide the United States with political and security advantages over other nations, and oil would not be a major consideration (Mabro 2003; Hinnebusch 2007; Marks 2013). Following this line, oil does not constitute the immediate reason for the Second Gulf War, but cannot be entirely disregarded in the broader picture (Khadduri 2011; Muttitt 2012).

Major concern arises over what Owen (2000) termed ‘the cumulative impact of repeated conflicts’. In this vein, the econometric model seeks to take into consideration the path dependency of these events by using a ‘step event variable’, as explained below.

One of the unique features of institutional change is that it cannot be easily or adequately quantified, which presents a serious obstacle for statistical analysis (Alston 1996). In modelling oil production, one can partially compensate for this problem by introducing ‘dummy’ variables (Lynch 2002). Because these sudden events (i.e., abrupt institutional changes) have effects that typically persist for decades, the step event variable is used to indicate these long-lasting shocks that alter the level of the series (Figure 1).
Model specification and data

The Hubbert model in its standard form is expressed in a logistic model as follows (Reynolds and Kolodziej 2008, 2009):

\[
CQP = \frac{URR}{1 + e^{-a(t-t_0)}},
\]

where \(CQP\) is cumulative production; \(URR\) is ultimately recoverable reserves; \(t_0\) represents the year of peak production; and \(a\) is the parameter that determines the initial rate of increase in production.

Deriving the cumulative production with respect to time, one obtains the following result:

\[
QP = \frac{dCQP}{dt} \text{ or } CQP = a \cdot URR \cdot e^{-a(t-t_0)} + e^{-a(t-t_0)}^{2}
\]

where \(QP\) is the current volume of production. It is important to recall here that the Hubbert model is a characterization of non-renewable (finite) resource production, which is driven by geological factors, where initially production grows slowly, subsequently accelerates and then starts to decline (Pesaran and Samiei 1995). In other words, Hubbert modelling is based on statistics in which the data of oil production are fitted on a logistic curve; and it is assumed that when half the oil reserves have been produced, the rate of oil production will reach its peak (Aleklett 2012). Though the Hubbert model is popular because it generated precise predications for the United States ‘lower-48’ oil production, the model’s predictive value as a forecast proved to be inaccurate for US gas production and world oil production in 2000 (Lynch 2002).

In many oil-producing countries, production may be subject to several production cycles, rather than a single cycle, as a result of socio-political upheavals (Anderson and Conder 2011). The concept of a single production cycle means production rises from zero until reaching its peak and then starts to diminish toward zero again. However, in some cases the production shifts direction before it reaches the zero level. It may, after decline has begun, start to show an increase to reach a new peak and then decrease to zero, thus creating a double production cycle (Wang et al. 2011). In this context, Hubbert (1956) has already admitted that:

For any production curve of a finite resource of fixed amount, two points are known at the outset, namely that at \(t = 0\), and again at \(t = \infty\) … the production rate must begin at zero, and then after passing through one or several maxima, it must decline again to zero. (9)

When dealing with real-world cases, the standard Hubbert model has been improved through the addition of more than one production cycle (Al-Fattah and Startzman 1999). In this manner, the model expands to a multi-cyclic Hubbert model. Each Hubbert cycle presumably reflects historical production data based on definable criteria for a specific region or field, or it might be attributable to the consequence of a shift in government that led to an abrupt change in the regulatory regime (Anderson and Conder 2011).

The standard Hubbert model can be alternatively expressed by solving the rate of production as a cumulative production subsuming time variable (Al-Jarri and Startzman
In this vein, the model could be equivalently represented as follows:

\[ QP = b_1 \times CQP + b_2 \times CQP^2 \]  

where \( QP \) is the annual rate of production; and \( CQP \) is cumulative production. The equation is called the quadratic Hubbert model. An econometric estimation of equation (1) would enable us to obtain \( URR \), which is the result of \( b_1 / b_2 \) (Reynolds and Kolodziej 2008). This represents an alternative approach to modelling the supply of oil; and it is one based on an engineering perspective in which the production volume is a function of cumulative production instead of a time variable (Reynolds and Kolodziej 2009). In this respect, Reynolds and Baek (2012) concluded that

The Hubbert curve economic model is similar to a normal supply model that takes account of labor, capital, technology and other inputs and their various costs; it is just that the Hubbert curve aggregates those inputs into a simple supply versus cumulative supply relationship.

When plotting the volume of Iraqi annual production as a function of cumulative production, the results (Figure 2) show that production is dependent on cumulative production rather on time, while the abrupt institutional changes constitute the major cause of volatility in annual production volume.

As the aim here is to deal with effects of the institutional changes on the volume of production, the article employs the model developed by Reynolds and Kolodziej (2008, 2009). Thus, equation (1) is utilized, with some modifications relevant to the case in hand.

In this regard, the historical production cycles were identified by inspecting both the history of the Iraqi oil industry and the OPEC database (see Saraiva et al. 2014 for the case of Brazil). Specifically, dummy variables were inserted; the value of the intervention's indicator variable is a \( 0 - 1 \), where 0 is before the date specified and 1 thereafter, so that the

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**Figure 2.** Iraqi oil production as a function of cumulative production, 1928–2015.
model becomes:

\[
QP = \beta_0 + \beta_1 \times CQP + \beta_2 \times CQP^2 + \beta_3 \times IND72 + \beta_4 \times IND72 \times CQP + \beta_5 \times IND81 \\
+ \beta_6 \times IND81 \times CQP + \beta_7 \times IND91 + \beta_8 \times IND91 \times CQP + \beta_9 \times IND03 \\
+ \beta_{10} \times IND03 \times CQP + \beta_{11} \times IND10 + \beta_{12} \times IND10 \times CQP + \epsilon_t
\]

where QP is the current rate of oil production; and CQP is cumulative oil production; IND72 is an indicator variable for nationalization equal to 1 in 1972 to the end of the sample, and zero otherwise; IND81 is an indicator variable for the Iraq–Iran War equal to 1 in 1981 to the end of the sample, and zero otherwise; IND91 is an indicator variable for the First Gulf War of 1990, equal to 1 in 1991 to the end of the sample, and zero otherwise; IND03 is an indicator variable for the Second Gulf War (Iraq War of 2003), equal to 1 in 2003 to the end of the sample, and zero otherwise; IND10 is an indicator variable for the new contractual forms with IOC, equal to 1 in 2010 to the end of the sample, and zero otherwise; \( \beta_0 \) is the intercept; \( \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}, \beta_{11} \) and \( \beta_{12} \) are coefficients; and \( \epsilon_t \) is the error term.

As it is dealing with more than one discrete institutional change, this model contains five indicator variables. Therefore, each single indicator variable is used in two terms to enable the cycle to occur in which the intercept and the slope change at the same point of time (Reynolds 2013; Kolodziej, personal communication, 30 April 2015).

The sample period is for 1928–2014, in which the starting point of the sample is based on the available data for production of oil in commercial quantity, while the closing date is 2014. Note that the location of the indicator variables is correlated to the actual events (i.e., the nationalization of oil and the outbreak of armed conflict).

**Empirical results**

**Results of unit roots tests**

Before estimating the model, the stationarity of the time-series is tested by applying the unit roots test, because non-stationary variables would result in a spurious regression in which the estimated coefficients are biased (Wooldridge 2013). In this context, the augmented Dicky–Fuller (ADF) test has been employed, using the software package Eviews 9. Table 2 shows the estimated statistics of the ADF test for the two variables.

The results indicate that the two variables are non-stationary at level I (I) for the sample. Thus, the presence of an I (1) trend would invalidate the results generated by ordinary least squares (OLS), which termed the relationship a spurious regression between unrelated variables (Granger and Newbold 1974). However, note that when the data are subject to structural changes, the ADF test can show a unit root, despite whether or not the model is

| Table 2. Results of the augmented Dicky–Fuller (ADF) unit-root test. |
|-------------------|-------------------|-------------------|-------------------|
| Variable          | ADF statistic     |                   |                   |
|                   | None              | Trend and intercept| Intercept         | Result |
| QP                | 0.31              | 1.56              | 4.06              | I(1)   |
|                   | (0.56)            | (0.49)            | (0.01)            |        |
| CQP               | 2.60              | 2.51              | 1.32              | I(1)   |
|                   | (0.99)            | (1.00)            | (0.87)            |        |
correctly specified (Reynolds and Kolodziej 2009). Therefore, the method established by Engle and Granger (1987) to determine whether the variables are co-integrated is followed. In this context, equation (2) is estimated first by using OLS and then the ADF test is used for the residuals to analyze the stochastic trend. In this way, the stationary results of the residuals would indicate whether or not the regression is spurious.

**Regression results**

The model is estimated by using OLS from the data for 1928–2014 to validate the hypothesis about the response of the volume of oil production to cumulative production and abrupt institutional changes. In this regard, the first independent variables (i.e., CQP and CQP2) are regressed to QP without any indicator variable and afterwards intervention variables are inserted chronologically, one after another, in a way that creates further Hubbert cycles. In this respect, the intervention variables are arranged according to the dates of their occurrence as sources of institutional change. Table 3 shows the statistical results for an OLS oil production model, which uses five inflection points (i.e., 1971, 1981, 1991, 2003 and 2010) to create the trend.

It is important here to highlight two important points. First, the OLS results of a single cycle are not applicable because they show a convex curve instead of a normal convex shape as determined by the theory (Reynolds and Kolodziej 2009). Second, after the insertion of intervention variables (IND81 and IND91) to create a triple and quadruple curve, the result shows that the intervention variables (IND91) are statically insignificant, and this also includes IND91*CQP. However, the results improved and became significant after inserting IND03 to create a quintuple cycle in which all the intervention variables became significant. This indicates that the Iraq multi-cycle model cannot be observed without the existence of intervention variable IND03.

The results, as expected, show that the production of oil experienced a negative impact because of the wars. In other words, the shock of the wars and their long-term consequences have a major negative impact on the level of production. Nevertheless, the magnitude of these impacts varied from one episode to the next. This is likely dependent on the initial conditions prevalent at the outset of the institutional change. In this respect, the negative effects of the wars on oil production differ greatly from one episode to the next, in accordance with variations in the scale of destruction affecting oil facilities, and political events associated with each particular war.

The results also show, more specifically, that the largest impact on oil production came from the First Gulf War, while the smallest impact resulted from the Iraq War of 2003. The estimations are consistent with economic logic and expectations. Namely, the physical destruction associated with the military operations of the First Gulf War was the greatest, which was followed by more than a decade of international sanctions. However, there is an exception regarding the impact of nationalization: IND72 is positive in the double-cycle equation, while the effect is transformed into negative when adding additional explanatory variables.

In this regard, Reynolds and Pippenger (2010) and Reynolds and Kolodziej (2007) claimed that the long-term impact of the change in ‘property right institutions’ from the environment of a relatively competitive market into nationalization and government control more likely would increase risk aversion, causing the decline in exploration and –
subsequently – reducing production. Even if one accepts the logic behind this causality and its validation in the cases of Venezuela and Russia, it is not possible to adduce a generalization that is universally applicable to all oil-producing countries. Actually, it is problematic to attempt to correlate this explanation with Iraq’s case, for two reasons. First, production and exploration increased significantly after nationalization, to reach the previous historical production peak in 1979 (OPEC 2008). Furthermore, there were undeniable efforts following nationalization in the downstream subsector also; and this included expanding refinery capacity and building a petrochemical project (Mahdi 2007b). Yet, the Iraq–Iran War decelerated and reversed this positive trend initially; and the First Gulf War and UN sanctions reversed it dramatically.

Table 3. Results of using a multi-cyclic Hubbert model.

<table>
<thead>
<tr>
<th>Number of Hubbert cycles</th>
<th>Number of indicator variables</th>
<th>Ordinary least squares (OLS) equation results</th>
<th>Log-likelihood</th>
<th>F-test results</th>
<th>Adjusted R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>0</td>
<td>$QP = 116,393 - 0.04*\text{CQP} - 6.18*10^{-10}\text{CQP}^2$</td>
<td>$-1191$</td>
<td>64.33</td>
<td>0.59</td>
</tr>
<tr>
<td>Double</td>
<td>1</td>
<td>$QP = 39,981 + 0.07*\text{CQP} + 1.69<em>10^{-9}\text{CQP}^2$ + $1,303,703</em>\text{DUM72} - 0.028*\text{DUM72}\text{CQP}$</td>
<td>$-1176$</td>
<td>61.54</td>
<td>0.73</td>
</tr>
<tr>
<td>Triple</td>
<td>2</td>
<td>$QP = 36,940 + 0.07*\text{CQP} + 7.75<em>10^{-10}\text{CQP}^2$ + $96,911</em>\text{IND72} - 0.13*\text{IND72}\text{CQP}$</td>
<td>$-1163$</td>
<td>(0.00)</td>
<td>0.80</td>
</tr>
<tr>
<td>Quadruple</td>
<td>3</td>
<td>$QP = 23,082 + 0.10*\text{CQP} - 3.40<em>10^{-9}\text{CQP}^2$ – $489,142</em>\text{IND72} + 0.04*\text{IND72}\text{CQP}$</td>
<td>$-1132$</td>
<td>97.74</td>
<td>0.89</td>
</tr>
<tr>
<td>Quintuple</td>
<td>4</td>
<td>$QP = 7102 + 0.13*\text{CQP} - 8.22<em>10^{-9}\text{CQP}^2$ – $1,164,932</em>\text{IND72} + 0.13*\text{IND72}\text{CQP}$</td>
<td>$-1102$</td>
<td>161.84</td>
<td>0.94</td>
</tr>
<tr>
<td>Sextuple</td>
<td>5</td>
<td>$QP = -6887 + 0.16*\text{CQP} - 1.24<em>10^{-8}\text{CQP}^2$ – $1,756,582</em>\text{IND72} + 0.20*\text{IND72}\text{CQP}$</td>
<td>$-1095$</td>
<td>155.30</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Note: Numbers in parentheses are p-values.
Second, due to the fact that the country experienced frequent institutional changes, it is almost impossible to distinguish between the long-term impact of nationalization and wars as sources of risk for investment. Admittedly, nationalization places the risk of investment on the government and its international relations in which geopolitical and international political economy matter. For its part, the Iraqi government managed these relatively well in the 1970s and 1980s (Jiyad, personal communication, 26 August 2016). However, it is quite clear that the burden of the increasing military expenditures in local and foreign currencies decreased the ability of the government to invest. One example might serve to illustrate this: the decline of Iraq’s share in the total value of projects signed by members of the Organization of Arab Petroleum Exporting Countries (OAPEC). According to Alnasrawi (1994), Iraq’s share almost doubled, reaching 31% in 1981 (compared with 17% in 1979), while the ratio declined drastically to 9% and then to 2% in 1982 and 1983, respectively.

On the other hand, one direct consequence of the Iraq War of 2003 was the lifting of the international sanctions, which paved the way for a new phase in development of the oil industry sector. Thus, there was an institutional change in terms of new contractual forms (i.e., LTSCs) which were adopted by the Ministry of Oil (MoO). This, in turn, paved the way for the entrance of IOCs, which bring modern technology and foreign expertise to the oil-producing sector. In this respect, the Grand Upstream Opening (GUO) occurred almost at the end of the data series in this study during 2009–10.

The results in Table 3 show that the new contractual form had surprisingly negative consequences on the production level, and the result is statistically significant. This is in contrast to the positive trend in production volume for 2009–15 (Table 4), especially given that the production volume increased in 2015 for the first time beyond its historical peak in 1979.

Thus, it is preferable here not to consider the results of a sextuple cycle, given that there are few data points after the change in institutions (new contractual form with IOCs); and

<table>
<thead>
<tr>
<th>Year</th>
<th>Government revenues from exported oil (Iraqi dinars, billions)</th>
<th>Average daily production (Mb/d)</th>
<th>Average actual price (US$/barrel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>41.32</td>
<td>2.336</td>
<td>58.83</td>
</tr>
<tr>
<td>2010</td>
<td>52.20</td>
<td>2.358</td>
<td>76.10</td>
</tr>
<tr>
<td>2011</td>
<td>61.83</td>
<td>2.652</td>
<td>104.97</td>
</tr>
<tr>
<td>2012</td>
<td>94.84</td>
<td>2.942</td>
<td>106.00</td>
</tr>
<tr>
<td>2013</td>
<td>83.16</td>
<td>2.979</td>
<td>102.31</td>
</tr>
<tr>
<td>2014</td>
<td>83.44</td>
<td>3.110</td>
<td>92.29</td>
</tr>
<tr>
<td>2015</td>
<td>49.02</td>
<td>3.504</td>
<td>44.70</td>
</tr>
<tr>
<td>Average 2009–15</td>
<td>66.54</td>
<td>2.840</td>
<td>83.60</td>
</tr>
</tbody>
</table>

Notes: aThe average rate of exchange for Iraqi dinars (ID) is 1316 for US$1 in 2003–12 (El-Joumayle 2016).
bThe volume of production for 2009–14 is from OPEC annual reports, while the figures reported by Alamir (2015) for 2009–14 have some minor differences from the OPEC figures.
There are significant differences in crude oil production figures reported by the US Energy Information Administration (EIA) (2016) for 2014 in comparison with the OPEC annual reports. The volume of production in 2014 is more about 400 kb/d, in comparison with the figure reported by OPEC for the same year. The discrepancy may lie partially in the inclusion of oil produced in the Iraqi Kurdistan region. Moreover, according to the EIA, the volume of production for 2015 is 4.10 Mb/d (nearly 85% was produced in southern Iraq and the remaining 15% is from northern Iraq), which increased by 700 kb/d over the previous year, 2014.
According to OPEC (2016), production in 2015 is 3.504 Mb/d, and it increased by 12.7% over 2014.
these data points are insufficient for the validation of the data used for forecasting the new peak (Reynolds and Kolodziej 2008) (Table 5).

Note, too, that any attempt to stimulate production in future faces a serious challenge in predicting the factors that may affect or interrupt future production, while the prediction implicitly assumes that the factors (i.e., abrupt institutional changes) that constrained the production in the past do not or will not apply in future (Anderson and Conder 2011). Therefore, it is preferable – at present, not – to refrain from using this model for predication of the next Hubbert peak. This having been said, the availability of additional data points in the near future might well prove helpful in constructing an updated model suitable for predicting the next peak.

The test of the residuals of the Hubbert model with quintuple cycles shows that the model seems to be valid, as it passed the unit root test (Table 6).

Finally, it is worth noting that the model measured the link between institutional change and oil production. However, institutional change cannot be considered the only determinant for oil production. There are other important variables that impact this, such as the price of oil and costs of extraction (Kaufmann and Cleveland 2001). Price has not formally been explored because, for most of the incidents, the decisions about production volume were influenced to a large extent by the unpredictable political dynamics associated with the institutional changes, with whatever market considerations there were usually coming in second place or after the fact (e.g., Mabro 1999 for the

| Table 5. Ordinary least squares (OLS) results on a five-cycle Hubbert curve. |
| Dependent variable: QD (volume of production) | Coefficient | SE | t-statistic | p |
| C | 7102 | 16,710.64 | 0.42 | 0.67 |
| CQP | 0.13 | 0.012778 | 10.76 | 0.00 |
| IND72 | -8.22E-09 | 1.75E-09 | -4.70 | 0.00 |
| IND72*CQP | 0.13 | 0.033620 | 3.95 | 0.00 |
| IND81 | -3.22E-09 | 475,594.4 | -6.78 | 0.00 |
| IND81*CQP | 0.15 | 0.029900 | 5.14 | 0.00 |
| IND91 | -3.82E-09 | 609,584.3 | -6.27 | 0.00 |
| IND91*CQP | 0.13 | 0.027733 | 4.85 | 0.00 |
| IND03 | -2.25E-09 | 961,896.9 | -2.34 | 0.02 |
| IND03*CQP | -0.05 | 0.033009 | 1.71 | 0.09 |

| R² | 0.955 | Mean dependent variable | 446,723.4 |
| Adjusted R² | 0.948 | SD dependent variable | 364,759.5 |
| SE of regression | 82,174.94 | Akaike information criterion | 25,58879 |
| Sum of squared residual | 5.13E+11 | Schwarz information criterion (SIC) | 25,900 |
| Log-likelihood | -1102 | F-statistic | 161.84 |
| Durbin–Watson statistic | 1.398 | Probability (F-statistic) | 0.00 |

Note: Sample, 1928–2014; number of observations: 87.

| Table 6. Results of the augmented Dicky–Fuller (ADF) unit root test for residuals. |
| ADF test statistic | None | Constant | Constant, linear trend |
| Test critical values | -7.44 (0.000) | -7.39 (0.000) | -7.34 (0.000) |
| 1% level | -2.59 | -3.50 | -3.06 |
| 5% level | -1.94 | -2.89 | -3.46 |
| 10% level | -1.61 | -2.58 | -3.15 |
sanction period). In point of fact, the cost of extraction for Iraqi oil is one of the lowest in the world; according to Shafiq (2013), the finding cost is a fraction of US$1 per barrel, while the development cost is about US$1.5–2 per every one discovered barrel; and the associated operating cost is about US$1.5–2. Thus, institutional change is arguably the most important factor influencing the volume of Iraq oil production; and this is reflected clearly in the high value of adjusted $R^2$ (i.e., 0.94). The formation of national oil policy and the economic and political fragmentation in the post-2003 war will be the subject of next section.

Discussion

This section traces briefly the actual changes in national oil policy in the post-2003 era and the major challenges ahead by placing them within the context of change in formal institutions. Specifically, this refers to changes in the management of the oil-producing sector away from nationalization that bring about after the abrupt change in political regime (Khadduri 2011). In this respect, the process of economic and political fragmentation of the Iraqi state is addressed. Then, some light is shed on the tensions and contentions between federal and regional authorities in connection with the formulation of oil policy in the post-2003 era.

Quite apart from Iraq’s oil policy, a serious economic problem was inherited from the past concerning the management of the economy. The Iraqi economy has undergone a gradual process of economic fragmentation since the mid-1970s. During the period when Iraq was under the iron grip of Saddam Hussein as president (1979–2003), management of the Iraqi economy was characterized and controlled more by a personal system, which weakened or undermined the role of state bureaucracy. Public economic organizations were transformed gradually into virtual ‘fiefdoms’, ruled by men whose essential qualification was to be found in their personal loyalty to the head of state – the individual to whom they would be accountable (Owen 2007; Zainy 2009). In addition, the recruitment and promotion of personnel in state organizations were also both guided predominantly by considerations of personal loyalty and membership in the ruling Ba’ath party, rather than regard for an individual’s education, skills or talents (Yousif 2016). Over time, the various bureaucracies lost almost any actual autonomy.

One direct consequence of the Iraq War of 2003 is that the previous structure of authority and the related decision-making institutions and organizational arrangements were demolished (Mahdi 2007b). The post-2003 political order faced serious obstacles in establishing new institutional arrangements. The hastily produced ‘constitution’ of 2005 reflects much of the extend mistrust inherited from the past and it remains a source for deeper divisions rather than a potential source of unity for Iraqis (Atiyyah 2008; Al-Oraibi 2013). Further, the 2005 constitution left a number of important issues in the oil industry, such as the control of new oil fields and unexplored oil areas, to be taken up later by the House of Deputies (Allawi 2007). This includes the nature of the relationship between regional and central governments as well as the distribution of oil resources (Tripp 2007).

Though one of the direct consequences of the First Gulf War was the diminishing control of central government on the three Kurdish governances in the north, the post-2003 era witnessed the consolidation of the authority of the Kurdistan Regional Government (KRG). In 1991–2003, the no-fly zone imposed by the United States, UK and France
in the north made the region a *de facto* autonomous zone in many respects (i.e., with regard to internal and military affairs), while the Iraq War of 2003 paved the way for the ratification of the new constitution in which the status of the Kurdish region became a *de jure* region within a federal Iraqi state (Stansfield 2013; Mills 2016). Even though the constitution included clear statements supporting the idea that the new Iraq state is a *federal* state, the matter is – in reality – still subject to ongoing debate in the political arena. On the one hand, Kurdish leaders consider their union with Iraq as dependent on the continued existence of their semi-autonomous region; and, on the other, many Iraqis remain believers in the concept of strong central government, and some maintain a sceptical view of federalism – seeing it as a first step toward an independent Kurdish state (O’Sullivan 2011).

Essentially, the new political order has faced, and is still facing, enormous pressure to accommodate the conflicting social and political demands of different groups that were suppressed under the dictatorship of Hussein and which have now come into prominence at one and the same time (see Alesina and Perotti 1994 for the relationship between democracy and growth). Most of these demands hinge on separate shares in natural resources and local tax measures (Al-Saadi 2006).

As a consequence, the ability of the new political order to consolidate these different demands has been decreased to a large extent and newly drafted laws usually face legislative deadlocks in the House of Deputies. The matter becomes even further complicated given that the previous trend of economic fragmentation is *accelerated* whenever the country witnesses an increasing breakdown in internal communication, along with the prevalence and dominance of ‘ethno-sectarian’ logic in the new political order in which the latter is implicitly conceded in the new constitution through the increasing autonomy of regional and local authorities (Owen 2007).

Therefore, the substantial economic fragmentation that the country inherited from the previous repressive political order has expanded to include fractures in political authority, after the overthrow of the regime in 2003.

The extent of Iraq’s political fragmentation may be illustrated by the opposition expressed continuously by the federal government over the KRG’s unilateralist approach to operating independently and endorsing PSCs with IOCs, while the federal government has struggled to pass national legalization in the House of Deputies without success (Zedalis 2007; Dargin 2009). The outcome of these attempts to establish new institutional arrangements in the hydrocarbon sector on the federal level is summarized by Cameron (2011):

> There is still no federal Oil and Gas Law; no revenue sharing law; no law establishing a NOC and no law that delimits the competence of the Iraqi Ministry of Oil as the regulator of oil and gas activities. In the absence of an Oil and Gas Law, there is no consensus about the process and authority for the negotiation and signature of new contracts. (89)

Hence, the federal government has utilized pre-2003-era legislation and legal power from the 2005 constitution when familiarizing LTSCs with IOCs (Cameron 2011).

According to O’Sullivan (2011), the root of tension between the federal government and the KRG can be summarized by two interconnected arguments: first, the question of who has the rights to develop the natural resources in the Kurdish region – and whether this rests with the federal or the regional entities; and, second, the question of what are the suitable contractual forms for the development of Iraq’s resources.
Much of the disagreement stems from the vague or ambiguous language of the 2005 constitution, which suggests that the federal government has primary authority over ‘existing’ fields, while the KRG is considered to be in charge of the development of ‘new fields’, which falls under the authority of the regional government (Jiyad 2010; Muttitt 2012). On this basis, the KRG claims that such fields can be developed without prior approval from the federal government. In the meantime, the KRG continues receiving its 17% allocation from the federal budget, which – significantly – is derived mainly from oil fields outside the Kurdish region (Muttitt 2012).

Away from consideration of any nationalist goals that would be involved in the PSCs, with regard to operational steps, the KRG has signed PSCs with IOCs, while the federal government believes LTSCs constitute the most appropriate way to utilize natural resources. Furthermore, the KRG began proposing such contracts even before an agreement was reached on the final form of new constitution (Wahab 2006; Cameron 2011). The issue of how to manage the federal budget, including the division and allocation of oil revenues, likewise constitutes a further source of aggravation (O’Sullivan 2011). Cameron (2011) even went so far as to argue that the KRG’s unilateralist approach must be viewed as part of the broader goal of establishing the economic base for an independent Kurdish state.

Nakhle (2008) discusses what she calls the ‘three pillars’ that are essential for the Iraqi oil industry to flourish. The first of these involves the need for transparency and establishing the right conditions for this in governance as well as political and legal contexts. The second is the creation of an INOC with world-class capabilities. The third involves establishing a new form of relationship with the IOCs based on long-term collaborations and partnerships. The question of advisability aside, events on the ground demonstrate that the first two of these pillars are a long way from being in place.

As the result of a lack of a unified oil policy, pursuing relationships with the IOCs has followed two different and competing paths on the part of federal and regional authorities, which precipitates further disintegration of the nation (Muttitt 2012).

It is also crucial to note that as a result of regime change and the subsequent ‘de-Ba’athification’ process, many high-level technocrats were purged or dismissed. With regard to the MoO, 17 out of 24 director generals have either been removed or left their posts, along with hundreds of mid-ranking technicians, while the recruitment of new staff has been predicated largely on membership in former opposition parties and according to ‘sectarian logic’ rather than rigorous considerations of relevant technical qualifications (Muttitt 2012).

In addition, the new political order, crystallized during 2005–07, has witnessed an acceleration in sectarian conflict and ethnic unrest – accompanied by waves of terrorist attacks, which have led to emigration of many middle-class professionals (Stiglitz and Bilmes 2010). These included large numbers of Iraqi managers, technocrats, university professors, physicians and other skilled workers (Yousif 2016). As a consequence, this has limited the number of qualified technocrats at different levels, which has reduced the regulatory capacity of the state in general, and the MoO in particular.

Within the same context, there has been inevitable economic dislocation and disorganization associated with the political change of 2003 (see Blanchard and Kremer 1997 for the case of Eastern Europe). In this respect, Mahdi (2007b) and Shafiq (2013) have noted that despite the re-establishment of intra-organizational authority of the federal
government and working protocols in the post-war era, communication between the various governmental departments remains in disarray and disrupted; and coordinated decision-making mechanisms are beset by serious impediments at both higher levels and joint-departmental levels. In addition, there have been frequent changes in personnel occupying the positions of director general in the MoO, which contribute to further management instability (Jiyad 2010). Moreover, the sectarian conflict and deep political crisis diverted some of the attention of the federal government away from development of the oil industry during 2003–08.15

The ‘third pillar’ posited by Nakhle (2008) pertains to the relationship and collaboration with IOCs. In principle, there is consensus among Iraqi oil experts that there is a need to collaborate with IOCs, given the semi-dilapidated state of the Iraqi oil industry – due to the depreciation of its facilities, and the fact that a significant part of it was either destroyed as a result of the wars or subject to cannibalization during the international sanctions period (Khadduri 2011).

Therefore, realistically speaking, the restricted availability of financial resources (Chalabi 1994; Al-Ameedi 2016) coupled with the deficit in administrative capabilities and skilled human resources are able to manage and maintain the operational process in oil projects (O’Sullivan 2011; Al-Ameedi 2016)16 renders the involvement of IOCs in the Iraqi upstream something of a necessity for decision-makers, rather than an ‘option’ (Nakhle 2008). In effect, before nationalization in 1972, INOC used the service contract as a method to develop the country’s oil resources. For instance, a contract was signed in the late 1960s with the French consortium ERAP (Farouk-Sluglett and Sluglett 2003; Zainy 2009), while in the 1970s, after nationalization, Iraq used technical assistance contracts, but the 1990s marked the onset of signing production-sharing agreements and service contracts called development and production contracts (DPCs), the latter of which remained in force until the outbreak of war in 2003 (Nakhle 2009). While the aim of the DPCs is rather more political than technical, since they were drafted in order to facilitate the lifting of UN sanctions, none of the four resulting contracts was implemented.

Nevertheless, there still exists among Iraqis a strong sentiment against bringing in IOCs to do the work, since they are seen as a source for reducing government sovereignty (Muttitt 2012; Al-Ghadhban 2015). In this respect, Nakhle (2008), affirmed that the answer lies largely in adopting effective regulations as a key for controlling oil resources, rather than opposing the contributions of IOCs.

Since oil revenues represent the biggest source of public expenditures, increasing production becomes a priority in the policy agenda, which reflects the actual need to cover the rehabilitation costs of the depleted oil industry infrastructure, as well as the necessity of financing government expenditures. However, oil revenues are vulnerable, being subject to declines in price or demand, or the emergence of new sources of supply outside OPEC, in addition to the possibility of any event that might cause the disruption of export facilities (Alnasrawi 1994). In other words, there is no guarantee that the federal government revenues will prove stable because the oil prices can potentially decline by more than the rise in production volume (Table 4).17

Admittedly, oil policy cannot be formulated in isolation from broad national economic policy, in which the former is integrated and seen beyond financial contribution (Mahdi 2007b; Al-Kāsim 2010). Actually, maximization of oil revenues constitutes a key long-term
policy objective, while the rational use of these revenues should also be considered (Jiyad 2013).

In contrast, much of the debate over oil policy has been concerned more with short-run financial outcomes than on formation of a long-term strategy for utilizing oil revenues to tackle Iraq’s economic and social problems (Al-Saadi 2010). Even with the acknowledgment by most of the political actors that there is a persistent need to increase the volume of production to finance the development process and rehabilitation of the economy, the notion of development has been narrowed down from improvement in goods-producing sectors (i.e., industry and agriculture) to limited focus on general progress in oil production, electricity and water treatment (Owen 2007). In sum, the long-term projects in the industry and agriculture sectors have not received the requisite attention (Sassoon 2011; Jiyad 2013).

Thus, the question that may rightly be asked is: what are the likely outcomes of the dual-path operational steps in terms of PSC and LTSC contract models with IOCs on the performance of the oil industry?

When the MoO contracts for the first- and second-bid rounds became effective in 2010, total production was at 2.35 Mb/d, and this increased to 3.50 Mb/d in 2015 (Table 4). So far this remains far below the ambitious initial production plateau announced by the MoO, which has set the goal of more than 12 Mb/d to be achieved by 2017 and lowered it to about 9 Mb/d by 2020. For its part, the KRG is not an exception in this regard; it likewise has reduced its previous targets to increasing production and pipeline capacity to 1 Mb/d by the end of 2016, instead of the end of 2015 or early 2016; but this goal is most probably unattainable (EIA 2016).

There is an additional factor influencing the KRG, which is that the Iraqi Kurdish region is landlocked, surrounded by neighbouring countries that have long-standing issues with the Kurdish populations within them (Dargin 2009). This geographical location has important implications for the oil industry. Actually, a major move away from Baghdad means that the bulk of the oil would be exported via a single export route: Turkey – even though there is a possibility of exporting limited quantities via Iran by tankers. This situation is tantamount to replacing the existing relationship with Baghdad, which is based on representation in different political institutions (i.e., the House of Deputies, presidency, deputy prime minister and a number of ministries), with a complete political and financial dependence on Ankara (Mills 2016).

While the increase of 1.14 Mb/d over five years shows a positive trend, it also reveals that the process of increasing production volume is not an easy task and one which requires time to be achieved (Jiyad 2014). Keeping in mind that previous experience indicates that translating Iraq’s oil industry promise into reality has been characterized – since the 1980s – by a chronic problem of carrying out plans for targeted production, interrupted by the various wars. Even though, there were short-lived success in 1976–80 and 1989–90, several upstream plans approved by the Iraqi government have not achieved the express targets: 5.5 Mb/d in the 1979–83 plan and 6.0 Mb/d in the 1990–94 plan (Al-Ghadhban 2015). Needless to say, the new political order’s hopes for a quick recovery in oil-production recovery have also proved untenable. This is shown in the Iraq Oil Ministry’s ambitious targets to produce 3 and 4 Mb/d by the end of 2004 and 2005, respectively – despite Iraq’s known capacities, the fragile security situation and the dire need of the hydrocarbon industry for a large volume of investment (The Open Society Institute &
The United Nations Foundation (2006). All this is in addition to increasing levels of corruption (Sawaan 2012; Yousif 2016). These factors demonstrate why the hoped-for quick recovery in oil production after 2003 was an unrealistic expectation.

Finally, the existing plans for rapid growth in oil production by pumping surplus oil into the international market in an attempt to boost revenues have their own limits. To all appearances, any future quota imposed from OPEC on Iraqi oil production would be very difficult to actually apply. Even though Iraq officials have acknowledged that Iraq is not in a position to compete with other OPEC members or in possession of the financial resources to develop a spare capacity (Al-Ghadhban 2015), an increase in production volume would be a source of future disagreement within OPEC (and with Saudi Arabia in particular, as the leading producer). Additionally, it is highly probable that the KRG will refuse to comply with any federal government directives for reducing the level of production (Mills 2016), while the KRG has established its own pipelines via Turkey.

In sum, the discernible future of the Iraqi oil industry remains occluded by clouds of uncertainty. The economic fragmentation inherited from the past accelerated after the 2003 war, in the midst of a political market based on ethno-sectarian components in which the political actors advance mutually exclusive and contradictory agendas, rather than working to hammer out a unified national vision for the shape of the oil industry and its role in economic development. In what has all the hallmarks of a vicious cycle, this political fragmentation has led to further economic fragmentation. Thus, the formulation of a proper and well-functioning federal oil policy will continue to remain out of reach because of the problematical and strained relationship between the federal government and the KRG (Jiyad 2010). The current price drop in crude oil to less than US$50 per barrel is also contributing an additional source of instability into Iraqi politics, and – in particular – the relationship between the federal government and the KRG (The Economist 2015).

Marks (2013) summarizes the actual challenges associated with oil and gas resources for the future of Iraq as a nation: ‘Hydrocarbons hold the key to finance Iraq’s reconstruction and modernization, they also provide the potential trigger for its next conflagration’ (35).

Conclusions

Iraq is an oil-rich developing country. It possesses the world’s fifth-largest proven reserves, which accounts for almost 9% of proven reserves globally and 18% of those within the Middle East (EIA 2016), while a considerable part of the country remains still unexplored.

In 2015, production volume increased for the first time to 3.50 Mb/d beyond its prior historical peak of 3.47 Mb/d in 1979. Thus, the country reclaimed its previous ranking as the second-largest oil producer among OPEC member states, after Saudi Arabia (OPEC 2016).

In order to capture quantitatively the effect of change in institutions on the volume of production, this article employed an extended version of the multi-cycle Hubbert model that was developed by Reynolds and Kolodziej (2008, 2009).

The statistical results of the longitudinal data (1928–2014) suggest that the model contributes meaningful information about the volatility of Iraq’s oil production. The model suggests persuasively that depletion in Iraqi oil production correlates to a question of change in institutions rather than purely geological or economics factors.
Though the simplicity of the Hubbert approach does manage accounting for abrupt institutional changes, the complexity of institutional change as a multilevel phenomena that involves numerous aspects makes it impossible for any empirical study to capture all these dimensions (Alston et al. 1996). By way of illustration, an example form the Iraq–Iran War can be noted. Alnasrawi (1994) referred to the long-term consequences of the war on Iraq’s oil; and this included – among other things – the adoption of austerity measures by the government that terminated a number of development projects as well as a loss in market share due to the decline in quantities of oil exported.

This article should not be misinterpreted as estimating the economic cost of the wars on Iraq’s oil-producing sector but instead should be understood as an attempt to capture the effects of abrupt institutional changes on the performance of this sector and its potential development.

In point of fact, in the post-2003 era, a complex political dynamic underlies the increasing economic fragmentation and differences over the extent of authority exercised by the federal government, the KRG and the provinces over oil and gas resources (O’Sullivan 2011). Thus, the new political order’s inability to establish an institutional framework for the oil industry is reflected in the lack of a unified national policy with realistic objectives. Even though one direct consequence is that the oil-producing sector has begun to revive and oil output has been moving upward, this positive trend has not been sufficient to offset the forces responsible for political and economic fragmentation.

Thus, it might be reasonably concluded that it is yet too early to assert that the increase in production volume heralds the beginning of a substantial rebound in the Iraqi oil-producing sector. On the contrary, the lack of long-term solutions for the political issues is only serving to increase the hazards confronting the future and continued existence of the entire nation (O’Sullivan 2011).

The Iraqi economy has now been placed now in the intractable position of having to balance the dire need to increase oil production against pervasive and high levels of political division, in which the political actors remain fractious and disunited. It might have been expected that, with time, these elements would have moved closer – under the influence of realpolitik – and away from their differences with a pragmatic convergence in their views. However, the opposite has transpired, and they have grown more polarized than ever before. Though political development is subject to internal, regional and international factors, Iraq remains under serious threat of further conflicts – including but not limited to the outgoing state of war with so-called Islamic State in Iraq and the Levant – which might well lead to the most probable scenario of geographical fragmentation based along ethno-sectarian lines.

Notes

1. The article focuses on the upstream subsector and, in particular, the volume of production of the petroleum sector divided into three subsectors: upstream (exploration, development and production), midstream (storage, pipeline and export outlets) and downstream (refining and gas processing).

2. Despite the substantial natural gas reserves, the export revenue from gas is very small; the revenue is derived from liquefied natural and propane gas shipments. While about 60% of the produced natural gas is flared, a substantial amount is reinjected to assist in crude oil recovery (Zedalis 2009).

4. The IPC and its two entities owned by the following four partners each held 23.75% (Zedalis 2009; Koucher 1999): BP; Royale Dutch Shell; Comagnie Francais des Petroles (CEF); and The Near Eastern Development Corporation (US). The remaining 5% is held by the Participation and Exploration Company (Gulbenkian).

5. According to Alnasrawi (1994), most of the oil produced in the world (excluding the United States and territories of the former USSR until the early 1970s) were produced by eight international oil firms integrated vertically: Exxon, Shell, BP, Mobil, Texaco, Gulf Oil Corporation (Gulf), Standard Oil of California (Chevron) and CFP. In 1960, 90% of operating companies in Iraq were owned by a number of these oil firms.

6. Iraqi crude oil was shipped by pipelines to the Iraqi town of Haditha, where the pipeline split into two branches: the first connected to Tripoli, Lebanon, the second to Haifa, which was part of the British Mandate Palestine (Zedalis 2009).

7. Iraq until 1959 was part of the sterling area. Thus, 1 Iraqi dinar (ID) = £1 sterling.

8. Farouk-Sluglett and Sluglett (1991) asserted that while the change from royalty rate to profit sharing had long faced opposition from the IPC, the crisis in Iran had undeniable influence on the company’s decision.

9. An alternative approach is dealing with the period 1928–2015 by examining it as four distinct periods instead of two as follows: 1928–58, 1958–79, 1980–2003 and 2003 to date. In this scheme, the second and fourth periods would be subject to in-depth analysis pertaining to institutional change (Jiyad, personal communication, 26 August 2016). However, this approach would be rather more suitable for a qualitative analysis than a quantitative one.

10. In this respect, Jiyad made the essential point that oil production under the concessions system that dominated Iraq prior to nationalization in the 1970s was hardly to be considered a competitive market rather than the monopoly of multi-international corporation (Jiyad 2016, personal communication).

11. For a detailed discussion of the constitution, see Jawad (2013).


13. Jiyad (2010) provides a detailed review for the points of disagreement between the federal government and the KRG.


15. According to Jiyad (2010), in the 2004–08 period, the MoO signed numerous memoranda of cooperation with IOCs with three main objectives: conduct of joint technical studies; training and development of staff; and technical consultancy. This was followed by technical support contracts that were supposed to be implemented during 2008–09. The major objective was addressing the decline of production in the primary oil fields.


17. In this respect, Jiyad (2011) explores four possible development scenarios for the Iraqi case, dubbed somewhat cynically: honeymoon, delicate balance, risky endeavours and nightmare.

18. Jiyad (2010) provides a useful assessment for the first- and second-round bids, including discussion of the mindset of the IOCs.

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